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Revision 1

Interim Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Area T

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

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Executive Summary

Waste Management Area (WMA) T, which contains the T Tank Farm, is regulated under RCW 70.105[1] and its implementing requirements in WAC 173-303-400.[2] The Washington State Department of Ecology (Ecology) has been authorized by the U.S. Environmental Protection Agency, in accordance with *Authorized State Hazardous Waste Programs*,[3] to conduct its hazardous waste regulatory program in lieu of the *Resource Conservation and Recovery Act of 1976* (RCRA),[4] including the requirements in 40 CFR 265, Subpart F.[5] The WMA T is also subject to the requirements of the *Hanford Federal Facility Agreement and Consent Order*,[6] with Ecology identified as the lead regulatory agency for the unit.

The WMA T was placed in assessment monitoring in 1993 due to elevated specific conductance. A groundwater quality assessment plan was prepared in 1993 (WHC-SD-EN-AP-132)[7] that described the monitoring activities to be used to determine whether WMA T had affected groundwater. That plan was updated in 2000 (PNNL-12057)[8] for continued RCRA groundwater quality assessment, as required by 40 CFR 265.93(d)(7).[9] The WMA T assessment plan was updated again in 2006 (PNNL-15301)[10] to include information obtained from seven new wells installed at the WMA after 1999 and information from routine quarterly groundwater monitoring during the previous 5 years. This document supersedes the 2006 assessment plan to include significant events that have occurred at WMA T since that time.

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[1] RCW 70.105, "Hazardous Waste Management," *Revised Code of Washington*, Olympia, Washington.

[2] WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code*, Olympia, Washington.

[3] *Authorized State Hazardous Waste Programs*, 42 USC 6926, et seq.

[4] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.

[5] 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," *Code of Federal Regulations*.

[6] Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

[7] WHC-SD-EN-AP-132, 1993, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

[8] PNNL-12057, 2001, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

[9] 40 CFR 265.93, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Preparation, Evaluation, and Response," *Code of Federal Regulations*.

[10] PNNL-15301, 2006, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T*, Pacific Northwest National Laboratory, Richland, Washington.

This plan describes the WMA T facility and operating history, waste characteristics, hydrogeology, previous monitoring at the WMA, groundwater and vadose zone contamination associated with the WMA, and the conceptual model for the WMA. This plan also addresses the following:

- Number, locations, and depths of wells in the WMA T groundwater monitoring network
- Sampling requirements and schedule for monitoring WMA T
- Analytes, groundwater parameters, and analytical methods for hazardous wastes or hazardous waste constituents in the groundwater related to historical facility operations
- Procedures for evaluating groundwater quality information
- Reporting requirements

This assessment plan is the principal controlling document for conducting groundwater monitoring at WMA T.

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Terms

amsl	above mean sea level
CAS	Chemical Abstract Services
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE	U.S. Department of Energy
DQO	data quality objective
DWS	drinking water standard
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ID	identification
NAVD88	North American Vertical Datum of 1988
OU	operable unit
PFP	Plutonium Finishing Plant
QAPjP	quality assurance project plan
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction-oxidation
SST	single-shell tank
TCE	trichloroethene
WMA	waste management area

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1 Introduction

Waste Management Area (WMA) T, which contains the T Tank Farm, is located in the northern portion of the 200 West Area of the Hanford Site (Figure 1-1). The WMA was used for interim storage of radioactive waste from chemical processing of reactor fuel for plutonium production. The WMA T is regulated under the *Resource Conservation and Recovery Act of 1976* (RCRA), as modified in 40 CFR 265, Subpart F ("Interim Status Standards for Owners and Operators of Hazardous Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"), RCW 70.105 ("Hazardous Waste Management Act"), and its implementing requirements in Washington State dangerous waste regulations (WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards"). The WMA T was placed in assessment monitoring in 1993 due to elevated specific conductance (a RCRA indicator parameter) in one downgradient well. Assessment monitoring has continued at WMA T since that time. The objectives for continued assessment of groundwater quality at WMA T, as required by 40 CFR 265.93(d)(7)(i) ("Preparation, Evaluation, and Response"), are to determine the following:

- Rate and extent of migration of the hazardous waste or hazardous waste constituents in the groundwater
- Concentration of hazardous waste or hazardous waste constituents in the groundwater

The scope of this plan is to acquire necessary groundwater data to achieve these objectives. The objectives are also related to the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) 200-ZP-1 Groundwater Operable Unit (OU) investigations and the vadose zone RCRA facility investigation/corrective measures study at WMA T. The integration of RCRA groundwater quality assessment with the 200-ZP-1 OU and the vadose zone RCRA facility investigation/corrective measures study requires consideration of certain nondangerous waste constituents and radionuclides, in addition to the dangerous waste constituents regulated under RCRA. Radionuclides are monitored under separate plans to support the objectives of CERCLA and the *Atomic Energy Act of 1954*.

This document is a revision of the previous groundwater assessment plan (PNNL-15301, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T*) and includes significant events that have occurred at WMA T since the previous plan was issued. This monitoring plan is prepared to be consistent, to the extent possible, with the final status monitoring plan that will be incorporated into the *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8C, for the Treatment, Storage, and Disposal of Dangerous Waste* (WA7890008967) in the future.

Chapter 2 of this plan summarizes background information, with reference to other documents for more detailed information. Chapter 2 also describes the WMA and the types of waste present, provides a brief history of groundwater monitoring, and discusses the geology and hydrology pertinent to WMA T. This information is summarized as a site conceptual model to aid in development of the groundwater monitoring program. Chapter 3 describes the RCRA groundwater monitoring program, including the wells in the monitoring network, constituents analyzed, sampling frequency, and sampling protocols. Chapter 4 describes data evaluation, interpretation, and reporting. A list of the references cited in this document is provided in Chapter 5. Appendix A provides the quality assurance project plan (QAPjP).

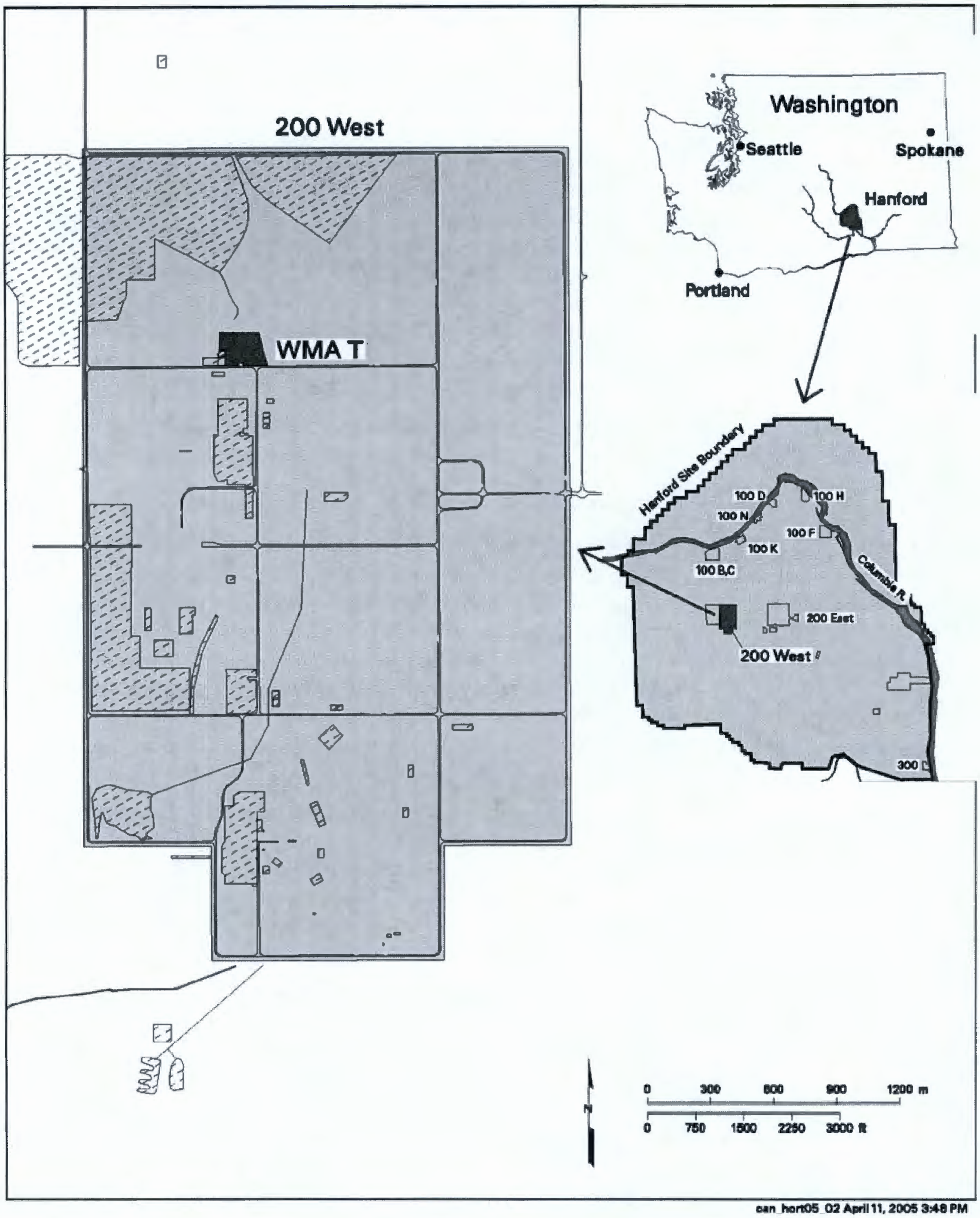

Figure 1-1. Location Map for WMA T

2 Background

This chapter describes the WMA T facility and its operating history. Discussion is also included on associated waste and waste characteristics at the WMA, local geology and hydrology, a summary of previous monitoring, groundwater and vadose zone contamination at the WMA, and a conceptual model.

The discussions in this chapter are summarized from previous documents, including the following:

- PNNL-13929, *RCRA Groundwater Quality Assessment Report for Single-Shell Tank Waste Management Area T (January 1998 Through December 2001)*
- PNNL-15301, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area T*
- PNNL-15837, *Data Package for Past and Current Groundwater Flow and Contamination Beneath Single-Shell Tank Waste Management Areas*
- RPP-23752, *Field Investigation Report for Waste Management Areas T and TX-Y*

2.1 Facility Description and Operating History

The WMA T is located in the northern portion of the 200 West Area (Figure 1-1). The WMA T contains 16 underground single-shell tanks (SSTs) that were constructed in 1943 and 1944. Twelve tanks (T-101 through T-112) have capacities of 2,000,000 L (530,000 gal), and four tanks (T-201 through T-204) have capacities of 208,000 L (55,000 gal). In addition to the tanks, six diversion boxes and ancillary pumps, valves, and pipes are included in the Dangerous Waste Permit Application Part A form (WA7890008967) for the T Tank Farm SST system.

The tanks in WMA T began receiving waste in 1944 and were mostly in continual use until 1980, at which time all tanks in the WMA were removed from service. The SSTs received predominantly high-level metal and first-cycle waste from chemical processing of uranium-bearing, irradiated reactor fuel rods. Lesser amounts of other wastes were also stored in the tanks at WMA T.

Waste management operations created a complex intermingling of tank wastes. Nonradioactive chemicals have been added to the tanks, and varying amounts of waste and heat-producing radionuclides have been removed. In addition, natural processes caused settling, stratification, and segregation of waste components. As a result, it is difficult to estimate the composition of the waste remaining in the tanks through operational records. A detailed history of tank farm operations is provided in *A History of the 200 Area Tank Farms* (WHC-MR-0132).

All pumpable liquid has been removed from the WMA T SSTs, and the tanks have been interim stabilized. Each tank currently contains less than 189,250 L (50,000 gal) of drainable interstitial liquid and less than 18,925 L (5,000 gal) of supernatant liquid (HNF-EP-0182, *Waste Tank Summary Report for Month Ending September 30, 2004*, Rev. 197).

Initial corrective actions have been implemented at WMA T. Berms were constructed around the T Tank Farm in 2001 to stop run-on of natural precipitation, and all known water lines have been tested or cut off. Finally, an interim surface barrier was placed over tank T-106 and nearby tanks to inhibit infiltration from mobilizing wastes that leaked from the tank in 1973. An interim measures maintenance plan consisting of annual inspections of drywell covers and visual inspections of run-off collection areas and culverts is in place and documented in the *Interim Measures Maintenance Plan* (WRPS-0900388).

Seven of the tanks at WMA T have been declared as leakers (Figure 3-1 in Chapter 3) based on liquid losses (HNF-EP-0182). Although HNF-EP-0182 provides estimated leak volumes for tanks T-107, T-108, T-109, and T-111 based on observed liquid levels in the tanks, neither the spectral gamma logging data (GJO-99-101-TAR/GJO-HAN-27, *Vadose Zone Characterization Project at the Hanford Tank Farms, T Tank Farm Report*) nor tank waste transfer records provide evidence of leaks from these tanks (RPP-7218, *Preliminary Inventory Estimates for Single-Shell Tank Leaks in T, TX, and TY Tank Farms*; RPP-23405, *Tank Farm Vadose Zone Contamination Volume Estimates*). It must be noted that spectral gamma logging in dry wells is only used to interrogate to a radius of 30.5 cm (12 in.) and, therefore, depends on the placement of the initial borehole. Contamination associated with these tanks may be the result of waste pipeline leaks or nearby tanks that are known to have leaked. The three largest leaks or releases from tanks in WMA T were from T-101, T-103, and T-106:

- Overfill of tank T-101 in 1969, with a loss of 38,000 L (10,000 gal) of reduction-oxidation (REDOX) cladding waste
- Overfill of tank T-103 in 1972 and 1973, with a loss of approximately 11,400 L (3,000 gal) of B Plant waste
- Leak of approximately 435,300 L (115,000 gal) of B Plant isotope recovery waste from tank T-106 in 1973

In addition to these releases, nine other unplanned releases have been documented in the area of WMA T. These unplanned releases are described in *T Plant Source Aggregate Area Management Study Report* (DOE/RL-91-61) and PNNL-15301.

2.2 Regulatory Basis

In May 1987, the U.S. Department of Energy (DOE) issued a final rule (10 CFR 962, "Byproduct Material") stating that the hazardous waste components of mixed waste are subject to RCRA regulations. In November 1987, the U.S. Environmental Protection Agency (EPA) authorized the Washington State Department of Ecology (Ecology) to regulate these hazardous waste components within the state of Washington (51 FR 24504, "EPA Clarification of Regulatory Authority Over Radioactive Mixed Waste"). In 1996, the Washington State Attorney General determined that the effective date of mixed waste in Washington State was August 19, 1987.

Groundwater monitoring is conducted at WMA T in accordance with 40 CFR 265, Subpart F (as referenced by WAC 173-303-400[3]). A detection-level RCRA groundwater monitoring program for WMA T was initiated in 1989 (WHC-SD-EN-AP-012, *Interim Status Groundwater Monitoring Plan for the Single-Shell Tanks* [Rev. 0, followed by Rev. 1 in 1991]). The WMA was placed in assessment monitoring in 1993 because specific conductance values in downgradient well 299-W10-15 exceeded the upgradient background (critical mean) value (WHC-SA-1124-FP, *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site*; WHC-SD-EN-AP-132, *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY*). The elevated specific conductance values dropped below the critical mean in 1994, but before the WMA could be returned to a detection-level monitoring program, specific conductance in another well increased and exceeded the critical mean in 1996. The presence of chromium, a dangerous waste constituent, in groundwater requires continued groundwater assessment. Subsequent assessment reports (PNNL-11809, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas T and TX-TY at the Hanford Site*; PNNL-13929) have not identified an upgradient source for the contamination observed in monitoring WMA T but have provided evidence linking some contaminants (including chromium) in groundwater to the WMA. Based on 40 CFR 265.93(d)(7), the owner/operator must continue to make the minimum required determinations of contaminant level and rate/extent of migration on a quarterly basis until final facility closure. Accordingly, continued groundwater assessment is required, and this plan describes the activities for the continued assessment.

2.3 Waste Characteristics

Three basic chemical-processing operations were the source of most of the hazardous waste transferred to the T Tank Farm, including the bismuth phosphate process, tributyl phosphate process, and REDOX process. The bismuth phosphate and REDOX processes were chemical separations programs for recovering plutonium from irradiated reactor fuels. The tributyl phosphate process recovered uranium metal in waste generated by the bismuth phosphate process. Waste from all three processes was made alkaline for storage in the tanks (WHC-MR-0132). WHC-MR-0132 provides the approximate chemical compositions for the major waste types sent to the T Tank Farm SSTs, and the *Hanford Soil Inventory Model, Rev. 1* (RPP-26744) provides detailed estimates for chemical and radioisotope concentrations for each tank leak in the WMA.

Table 2-1 lists the dangerous wastes specified in the Dangerous Waste Permit Application Part A form (WA7890008967).

Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)

Dangerous Waste Code	Contaminant Description	Dangerous Waste Code	Contaminant Description
D001	Ignitable waste	D030	2,4-Dinitrotoluene
D002	Corrosive waste	D033	Hexachlorobutadiene
D003	Reactive waste	D034	Hexachloroethane
D004	Arsenic	D035	Methyl ethyl ketone
D005	Barium	D036	Nitrobenzene
D006	Cadmium	D040	Trichloroethene
D007	Chromium	D041	2,4,5-Trichlorophenol
D008	Lead	D043	Vinyl chloride
D009	Mercury	F001	1,1,1-Trichloroethane
D010	Selenium	F002	Methylene chloride
D011	Silver	F003	Acetone, methyl isobutyl ketone
D018	Benzene	F004	Cresol-m, -o, -p
D019	Carbon tetrachloride	F005	Methyl ethyl ketone
D022	Chloroform	WP01	Extremely hazardous waste/ persistent dangerous waste
D028	1,2-Dichloroethane	WP02	Dangerous waste/ persistent dangerous waste

Table 2-1. Dangerous Wastes in the Single-Shell Tank System (Dangerous Waste Permit Application Part A Form)

Dangerous Waste Code	Contaminant Description	Dangerous Waste Code	Contaminant Description
D038	Pyridine	WT01	Extremely hazardous waste/ toxic dangerous waste
D029	1,1-Dichloroethylene	WT02	Dangerous waste/toxic dangerous waste
D039	Tetrachloroethylene		

Notes:

1. This table is based on the Dangerous Waste Permit Application Part A form (WA789000896).

2. Analytes associated with the "F001" through "F005" waste codes are from WHC-MR-0517, *Listed Waste History at Hanford Facility TSD Units.*

2.4 Geology and Hydrogeology

This section describes the geology and hydrology beneath the SST WMA T. The geology specific to WMA T was first described in *Geology of the 241-T Tank Farm* (ARH-LD-135) and later in WHC-SD-EN-AP-012. Summaries of the geology at WMA T are also provided in *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination* (HNF-2603) and *Subsurface Conditions Description of the T and TX-TY Waste Management Areas* (RPP-7123).

More recently, the *Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site* (RPP-23748); *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site* (PNNL-15955); PNNL-15301; and PNNL-15837 provided updated information on the geology and hydrology at WMA T, including the most recent observations from new wells.

The vadose zone beneath WMA T is between approximately 70 and 76 m (229 and 249 ft) thick and consists of the Hanford formation, the Cold Creek unit, the Taylor Flats member of the Ringold Formation, and the upper portion of Unit E of the Wooded Island member of the Ringold Formation. The water table is at approximately 134.5 m (441.3 ft) in elevation (March 2009). The unconfined aquifer beneath WMA T is estimated to be approximately 48 to 51 m (157 to 167 ft) thick based on water levels and the depth of the Ringold Formation lower mud unit, which serves as a confining or semiconfining layer separating the unconfined aquifer from a confined, or partly confined, aquifer in the underlying Ringold Formation Unit A. Figure 2-1 shows a generalized hydrostratigraphic column for the WMA T area.

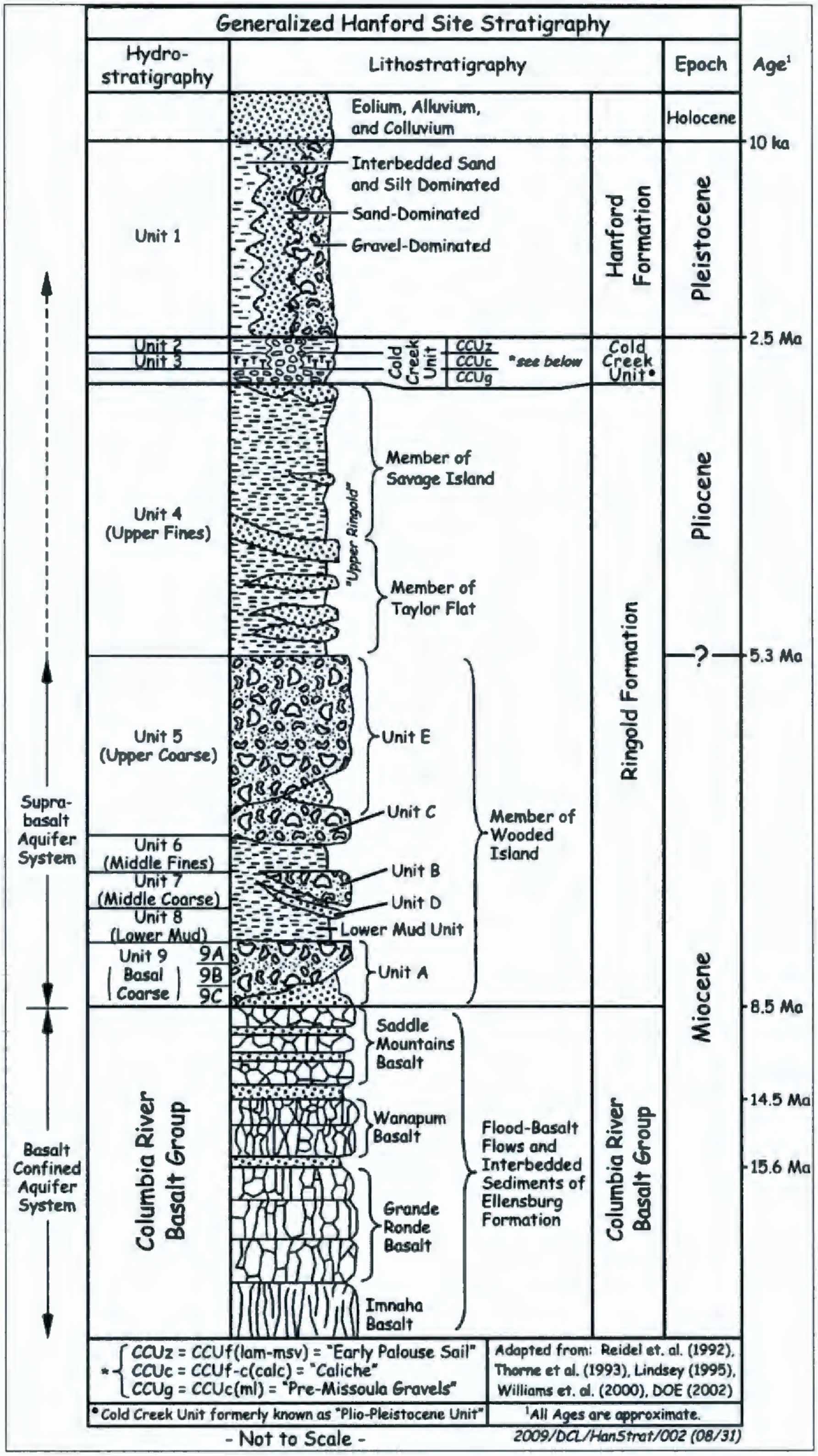

Figure 2-1. Generalized Stratigraphy of the Hanford Site

Water levels in the unconfined aquifer increased as much as 13.5 m (44.3 ft) (above the pre-Hanford natural water table) beneath WMA T due to artificial recharge from liquid waste disposal operations between the mid-1940s and 1995. During that time, the groundwater flow direction changed from eastward (the pre-Hanford direction) to southward, then northward, and finally back toward the east as a result of changes in waste management practices. More recently, two monitoring wells east of WMA T were converted to extraction wells for the removal of technetium-99 at the 200-ZP-1 OU, which enhanced the eastward flow of groundwater. The large shifts in groundwater flow direction have large implications for contaminant distribution in the uppermost aquifer beneath WMA T.

Groundwater levels continue to decline due to cessation of artificial recharge from liquid waste disposal operations in the area, as shown in Figure 2-2.

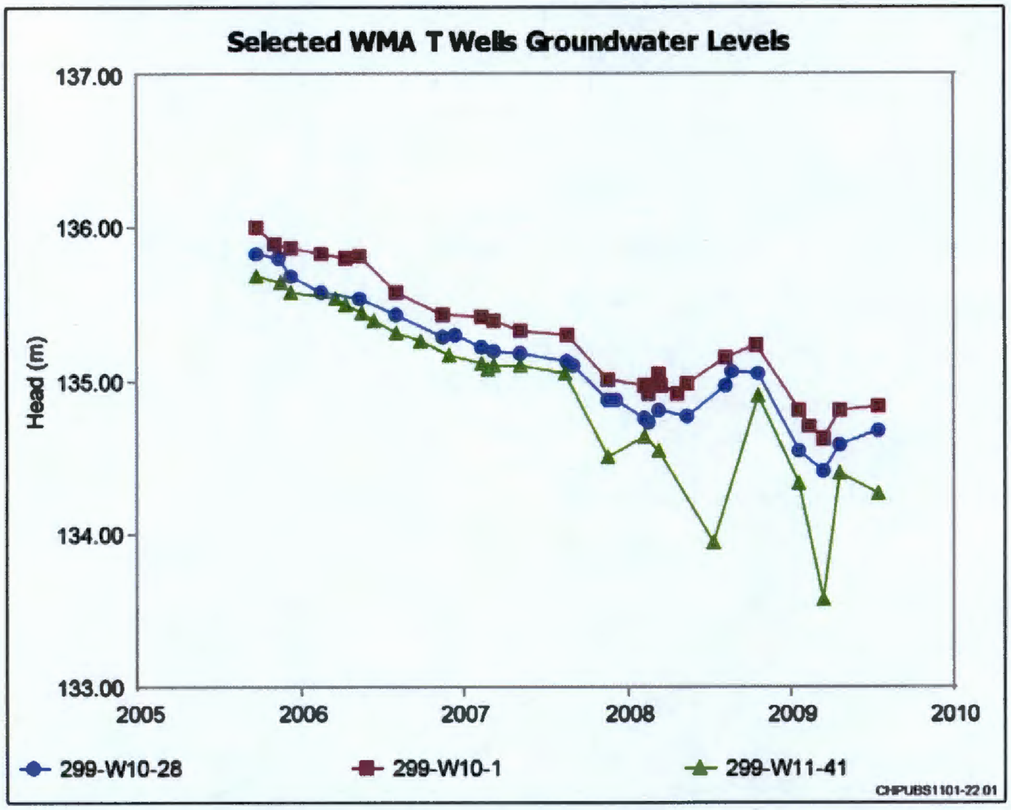

Figure 2-2. Selected Monitoring Wells Showing Groundwater Level Declines in WMA T

Since 1999, several aquifer tests have been performed at the new wells at WMA T. Details of the tests, data analyses, and test results are provided in the following documents:

- PNNL-13378, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 1999*
- PNNL-14113, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2001*
- PNNL-14186, *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2002*

- PNNL-17348, *Results of Detailed Hydrologic Characterization Tests – Fiscal and Calendar Year 2005*
- PNNL-17732, *Analysis of the Hydrologic Response Associated with Shutdown and Restart of the 200-ZP-1 WMA T Tank Farm Pump-and-Treat System*

The salient results of the aquifer tests are summarized below:

- Local hydraulic conductivities are between approximately 6.1 and 9.7 m/d (20 and 31.8 ft/d).
- The vertical in-well flow rates range from 0.001 to 0.017 m/m (downward), determined during testing in two wells in the WMA T well network.
- Vertical heterogeneities in hydraulic conductivity were recognized among wells and within individual well screens.

Prior to conversion of wells 299-W11-45 and 299-W11-46 to 200-ZP-1 OU pump-and-treat extraction wells, the water table gradient beneath WMA T was approximately 0.001 (PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*). After conversion of the extraction wells, the gradient increased to approximately 0.0024 (based on March 2011 water levels). Using a water table gradient of 0.002, an effective porosity of 0.1, and the range of hydraulic conductivities obtained from aquifer tests, the groundwater flow rate beneath WMA T is between 0.12 and 0.19 m/d (0.39 and 0.62 ft/d). Figure 2-3 provides a groundwater map for WMA T in 2011.

2.5 Summary of Previous Groundwater Monitoring

This section summarizes the current and historical groundwater contamination at WMA T. Vadose zone contamination is also summarized because any residual vadose zone contamination is a potential source for future groundwater contamination.

2.5.1 Groundwater Contamination

The primary RCRA dangerous constituents found beneath WMA T in 2011 were chromium, carbon tetrachloride, and trichloroethene. The source for the carbon tetrachloride and trichloroethene was attributed to liquid disposal associated with processes at the Plutonium Finishing Plant (PFP) and not WMA T. These constituents are monitored as part of the 200-ZP-1 Groundwater OU. Nitrate and fluoride are also found in the groundwater beneath the WMA and are monitored for groundwater quality purposes. Plume maps for all of these constituents are included in *Hanford Site Groundwater Monitoring for 2011* (DOE/RL-2011-118).

2.5.1.1 Chromium

Chromium is the dangerous waste constituent monitored under the RCRA assessment program. Chromium concentrations exceeded the drinking water standard (DWS) (100 µg/L) in eight wells during routine sampling at WMA T during 2011. The highest chromium concentrations in wells screened at the water table have historically been in well 299-W10-4, which is located south of WMA T. Recent chromium contamination at WMA T is discussed further in DOE/RL-2011-118.

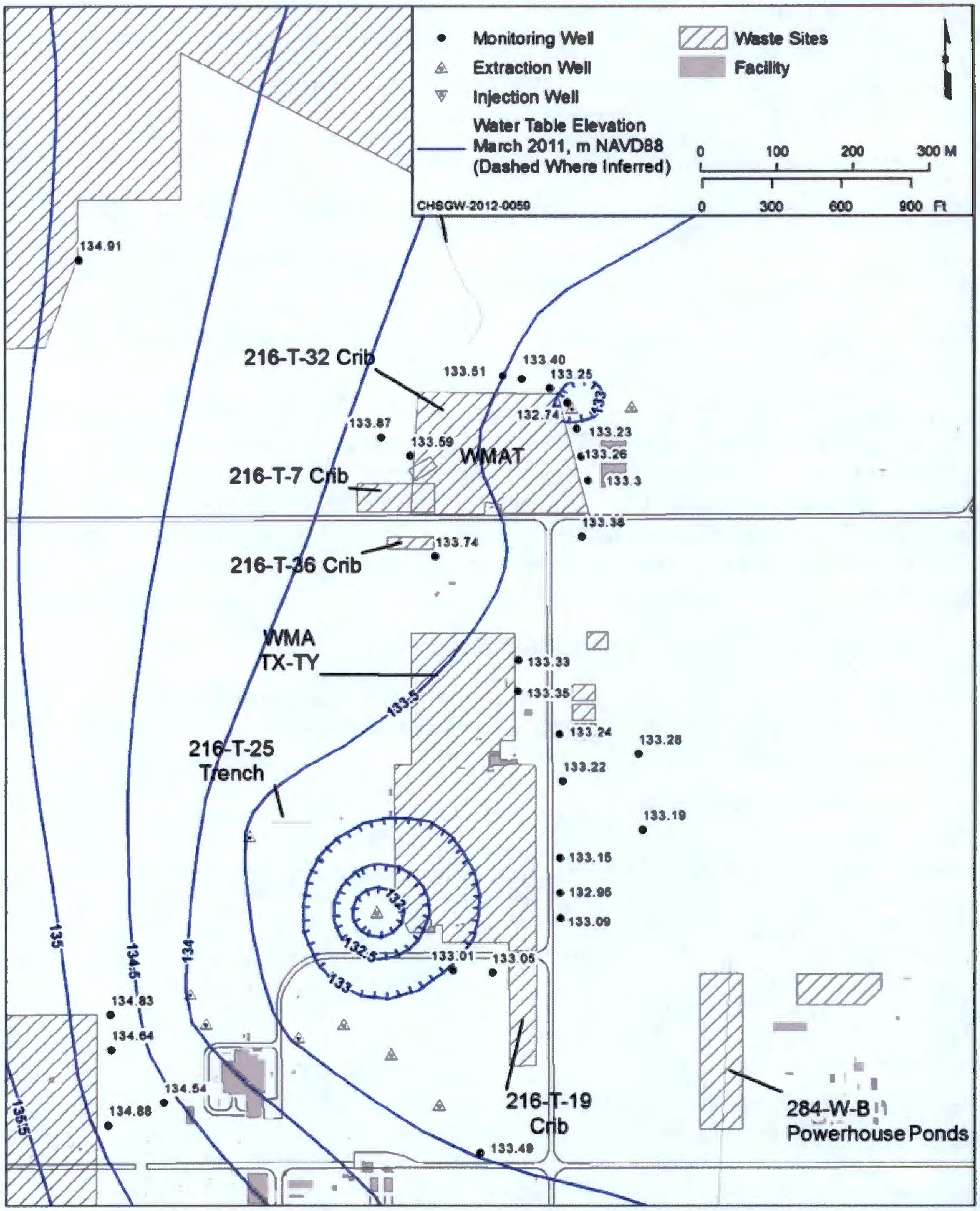

Figure 2-3. Water Table Map for the Area Surrounding WMA T, 2011

2.5.2 Vadose Zone Contamination

Three investigation techniques provided evidence regarding the extent of contamination in the vadose zone at WMA T:

- Geophysical logging of dry wells associated with each SST (GJO-99-101-TAR/GJO-HAN-27; GJO-99-101-TARA/GJO-HAN-27, *Addendum to the T Tank Farm Report*)
- Coring through the leak plume from tank T-106 (PNNL-14849, *Characterization of Vadose Zone Sediments Below the T Tank Farm: Boreholes C4104, C4105, 299-W10-196, and RCRA Borehole 299-W-11-39*)
- High-resolution resistivity geophysical surveys (RPP-RPT-28955, *Surface Geophysical Exploration of T Tank Farm at the Hanford Site*)

Pertinent conclusions from the vadose zone investigations include the following:

- Significant levels of contamination exist within the vadose zone to depths of at least 37 m (123 ft). The vertical extent of the contaminant plumes is not fully defined because a number of boreholes are contaminated to total depth (GJO-99-101-TARA/GJO-HAN-27).
- Evidence from boreholes C4104 and C4105, drilled through the T-106 tank leak vadose zone plume, suggests that contaminants from the tank T-106 leak have reached a depth of at least 39 m (127 ft) (PNNL-14849).
- High-resolution resistivity surveys suggest that vadose zone contamination extends from the bottom of the 216-T-7 Crib and Tile Field to the water table.
- Evidence from high-resolution resistivity surveys suggests that vadose zone contamination beneath the 216-T-14 through 216-T-17 Trenches is contained within the upper portion of the vadose zone (RPP-RPT-28955). However, these trenches are not within the WMA T treatment, storage, and disposal unit boundary and are only referred to as a nearby source of vadose zone contamination immediately northeast of the treatment, storage, and disposal unit.

2.6 Conceptual Model

PNNL-15301 describes the conceptual model for WMA T. The conceptual model illustrates the complexity and the spatial and temporal relationships of five important parameters, which are outlined in this section:

- Contaminant sources
- Driving forces
- Migration pathways to groundwater
- Changes in groundwater flow direction and flow rate
- Current contaminant distributions in the aquifer

2.6.1 Contaminant Sources

Several potential sources for groundwater contamination exist in the WMA T area, including tank leaks; liquid wastes disposed to past-practice facilities (located northeast, west, and southwest of WMA T); unplanned releases (including leaking pipelines); and regional contamination from far-field sources (e.g., PFP).

- All tanks in WMA T have been interim stabilized, so no threat exists for future releases from large tank leaks. However, contaminants remaining in the vadose zone from past tank leaks have the potential to reach groundwater. Some evidence suggests that past tank leaks have migrated through the vadose zone to the groundwater (PNNL-15301; PNNL-15837); however, this evidence is not unequivocal.
- Earth resistivity surveys have shown that vadose zone contamination extends from the base of the 216-T-7 Crib and Tile Field to the water table. Thus, at least some of the nearby past-practice disposal facilities have impacted groundwater.
- Pipeline leaks and overfilling of SSTs have been documented at WMA T (RPP-7218). Any remaining contamination in the vadose zone resulting from pipeline leaks or overfill events remains a source for possible future groundwater contamination.
- Regional sources are responsible for most of the carbon tetrachloride and much of the nitrate found in the groundwater beneath WMA T.

2.6.2 Driving Forces

In general, contaminants are transported to groundwater in two ways: (1) transport associated with very large leaks when the amount of liquid is sufficient to reach groundwater through gravitational forces and capillary action, and (2) transport associated with an external source of water (or other liquid) available to remobilize residual waste in vadose zone plumes. The SSTs in WMA T no longer contain large amounts of liquid waste; thus, large tank leaks emanating from WMA T are not likely.

All intentional disposal of water to non-permitted facilities ceased in 1995; therefore, effluent disposal to nearby ponds, cribs, and ditches is no longer mobilizing vadose zone contamination to the groundwater. All known water lines in WMA T have been tested and cut off (DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*). It is possible, but unlikely, that a previously unidentified water line will leak and substantially mobilize existing vadose zone contamination to groundwater in the area.

Infiltration of natural precipitation remains the likely principal driver to mobilize vadose zone contamination. Steps have been taken to reduce infiltration or precipitation at WMA T. Berms have been erected around the tank farm to stop run-on of rain and melting snow, and an interim cap has been placed over the largest tank leak in the WMA (T-106) to inhibit remobilization of that leak.

2.6.3 Migration

Contaminant migration through the vadose zone is not well understood because it is highly dependent on heterogeneities and anisotropy in the soil properties. Heterogeneities at smaller than formation scale also affect flow and transport, as evidenced by logs of drywells and cone penetrometer logs that reveal moisture-rich strata, likely reflecting finer grained units with permeability contrast.

The sediment layers with the most influence on moisture migration through the vadose zone beneath WMA T are the Cold Creek unit and the Taylor Flats member of the Ringold Formation. The relatively low permeability of these units is expected to impede vertical moisture migration. The Cold Creek unit is known to pond water locally in several places in the 200 West Area.

Improperly sealed wells can act as a preferential pathway through the vadose zone. Documentation in *Hanford Wells* (PNL-8800) indicates that 45 of the 67 dry wells in the T Tank Farm (used for secondary leak detection) have been modified to retrofit an annular seal. No documentation is provided in PNL-8800, the Hanford Well Information System database, or the Pacific Northwest National Laboratory well library that the remaining 22 dry wells have an annular seal. Therefore, the potential exists for unsealed wells to promote vertical moisture migration in WMA T.

The groundwater flow rate at WMA T is on the order of 0.12 to 0.19 m/d (0.39 to 0.62 ft/d). Some contaminants will travel at a rate slower than this, depending on the chemical properties of specific contaminants. Chromium and nitrate are the most mobile chemical contaminants associated with WMA T.

2.6.4 Changing Groundwater Flow Direction

Large changes have occurred in the groundwater flow direction beneath WMA T. Analyses of historic hydraulic gradients suggest that groundwater could have traveled and carried contaminants from WMA T and nearby past-practice disposal facilities. Approximate travel directions and distances are as follows (PNNL-15301):

- 34 m (112 ft) toward the south between 1954 and 1957
- 170 m (558 ft) northeast between 1957 and 1982
- 110 m (361 ft) north or northwest between 1983 and 1995
- 32 m (105 ft) toward the east between 1997 and 2004

Although these distances are estimates, they show that changes in the groundwater flow direction could have contributed to relatively widespread contaminant distribution. Water levels also continue to decline in the area since the cessation of liquid waste disposal operations (Figure 2-2).

The recently installed 200 West pump-and-treat system is expected to change groundwater flow direction and flow velocity at WMA T. Since this pump-and-treat system is just now coming on line, the magnitude and direction of the changes are not yet known.

2.6.5 Contaminant Distribution

The current understanding of the spatial distribution of contaminants at WMA T is shown in recent plume maps (DOE/RL-2011-118). The eastern extent of contamination is not well defined. Several lines of evidence show that vertical contaminant concentration gradients exist in the area of WMA T. Contaminant concentrations increase with depth in the aquifer in some places and decrease with depth in other places.

2.7 Data Quality Objectives

To define the required information for groundwater indicator evaluation monitoring, the data quality objectives (DQO) process is used to ensure that data gathered are of the appropriate quantity and quality to meet specific objectives. Table 2-2 outlines the DQO parameters, regulatory interim status requirements, and associated reports supporting the regulatory requirements.

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA T

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Scope	**40 CFR 265; incorporated by reference in WAC 173-303-400(3)(a), as modified by WAC 173-303-400(3)(b) and WAC 173-303-400(3)(c)(v)(E)** **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator: (i) Must continue to make the determinations required under paragraph (d)(4) of this section… **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water. **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(3) The plan to be submitted under 40 CFR 265.90(d)(1) or paragraph (d)(2) of this section must specify: (i) The number, location, and depth of wells; (ii) Sampling and analytical methods for those hazardous wastes or hazardous waste constituents in the facility; (iii) Evaluation procedures, including any use of previously gathered ground-water quality information; and (iv) A schedule of implementation.	PNNL-15301, RCRA *Assessment Plan for Single-Shell Tank Waste Management Area T* This plan, Sections 3.1 and 3.2, Chapter 4, and Appendix A
Number and location of wells Point(s) of compliance	**40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	PNNL-15301, RCRA *Assessment Plan for Single-Shell Tank Waste Management Area T* This plan, Chapters 1 and 3, and Appendix A

Table 2-2. DQO Parameters, Associated Regulatory Requirements, and Documentation for WMA T

DQO Parameter	Related Requirements	Plan Criteria and Associated Historical Documentation
Well configuration (depth and length of screened interval; well construction)	**40 CFR 265.91, "Ground-Water Monitoring System."** (c) All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened or perforated, and packed with gravel or sand where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space (i.e., the space between the borehole and well casing) above the sampling depth must be sealed with a suitable material (e.g., cement grout or bentonite slurry) to prevent contamination of samples and the ground-water. **Additional Requirements from WAC 173-303-400(3)(c)(v)(C).** Ground-water monitoring wells must be designed, constructed, and operated so as to prevent ground water contamination. WAC 173-160 may be used as guidance in the installation of wells.	PNNL-15301, RCRA *Assessment Plan for Single-Shell Tank Waste Management Area T* This plan, Section 3.2 and Appendix A
Frequency of sampling Types of analysis or measurement Method detection limits or accuracy and precision Methods used to evaluate the collected data	**40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(7) If the owner or operator determines…that hazardous waste or hazardous waste constituents from the facility have entered the ground-water, then the owner or operator: (i) Must continue to make the determinations required under paragraph (d)(4) of this section <u>on a quarterly basis</u> until final closure of the facility, if the ground-water quality assessment plan was implemented prior to final closure of the facility; or (ii) May cease to make the determinations required under paragraph (d)(4) of this section, if the ground-water quality assessment plan was implemented during the post-closure care period. **40 CFR 265.93, "Preparation, Evaluation, and Response."** (d)(4) The owner or operator must implement the ground-water quality assessment plan which satisfies the requirements of paragraph (d)(3) *[see scope in first row of this table]* of this section, and, at a minimum, determine: (i) The rate and extent of migration of the hazardous waste or hazardous waste constituents in the ground-water; and (ii) The concentrations of the hazardous waste or hazardous waste constituents in the ground-water.	PNNL-15301, RCRA *Assessment Plan for Single-Shell Tank Waste Management Area T* This plan, Section 3.1, Chapter 4, and Appendix A

Notes: The references cited in this table are listed in the reference section (Chapter 5) of this plan.

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3 Groundwater Monitoring Program

This chapter lists the wells monitored, constituents analyzed, and sampling frequency for WMA T. The quality assurance and quality control requirements are provided in the QAPjP (Appendix A).

3.1 Constituent List and Sampling Frequency

The constituent list for groundwater sampling consists of RCRA-regulated analytes that may be present in SST waste. To identify these analytes, the list of primary nonradiological constituents potentially present in SST waste (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*) was compared to those constituents listed in Appendix 5 of Ecology Publication 97-407 (*Chemical Testing Methods for Designating Dangerous Waste: WAC 173-303-090 & -100*), which references 40 CFR 264, Appendix IX ("Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring List"). Those constituents identified in RPP-23403 that are RCRA-regulated (i.e., listed in Appendix 5 of Ecology Publication 97-407) are included in Table 3-1.

Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System

Constituent	CAS ID	Constituent	CAS ID
Volatile Organic Compounds			
1,1,1-Trichloroethane	71-55-6	Chloroform	67-66-3
1,1,2,2-Tetrachloroethane	79-34-5	Ethylbenzene	100-41-4
1,1,2-Trichloroethane	79-00-5	Isobutanol	78-83-1
1,1-Dichloroethene	75-35-4	Methylene chloride	75-09-2
1,2-Dichloroethane	107-06-2	Tetrachloroethene	127-18-4
2-Butanone (methyl ethyl ketone)	78-93-3	Toluene	108-88-3
2-Propanone (acetone)	67-64-1	trans-1,3-Dichloropropene	10061-02-6
4-Methyl-2-pentanone (MIBK)	108-10-1	Trichloroethylene	79-01-6
Benzene	71-43-2	Trichlorofluoromethane	75-69-4
Carbon disulfide	75-15-0	Vinyl chloride (chloroethene)	75-01-4
Carbon tetrachloride	56-23-5	Xylenes	1330-20-7
Chlorobenzene	108-90-7		
Semivolatile Organic Compounds			
1,2,4-Trichlorobenzene	120-82-1	Aroclor 1260	11096-82-5
2,4,5-Trichlorophenol	95-95-4	Butylbenzylphthalate	85-68-7
2,4,6-Trichlorophenol	88-06-2	Di-n-butylphthalate	84-74-2

Table 3-1. RCRA-Regulated Constituents Potentially Present in the Single-Shell Tank Farm System

Constituent	CAS ID	Constituent	CAS ID
2,4-Dinitrotoluene	121-14-2	Di-n-octylphthalate	117-84-0
2-Chlorophenol	95-57-8	Fluoranthene	206-44-0
2-Methylphenol (o-cresol)	95-48-7	Hexachlorobutadiene	87-68-3
3-Methylphenol (m-Cresol)	108-39-4	Hexachloroethane	67-72-1
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	Naphthalene	91-20-3
4-Methylphenol (p-cresol)	106-44-5	Nitrobenzene	98-95-3
Acenaphthene	83-32-9	n-Nitroso-di-n-propylamine	621-64-7
Aroclor 1016	12674-11-2	n-Nitrosomorpholine	59-89-2
Aroclor 1221	11104-28-2	1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1
Aroclor 1232	11141-16-5	2-Nitrophenol (o-Nitrophenol)	88-75-5
Aroclor 1242	53469-21-9	Pyrene	129-00-0
Aroclor 1248	12672-29-6	Pyridine	110-86-1
Aroclor 1254	11097-69-1		
Inorganic Constituents (Nonradiological)			
Antimony (Sb)	7440-36-0	Mercury (Hg)	7439-97-6
Arsenic (As)	7440-38-2	Nickel (Ni)	7440-02-0
Barium (Ba)	7440-39-3	Selenium (Se)	7782-49-2
Beryllium (Be)	7440-41-7	Silver (Ag)	7440-22-4
Cadmium (Cd)	7440-43-9	Sulfide (S^{2-})	18496-25-8
Chromium (Cr)	7440-47-3	Thallium (Tl)	7440-28-0
Cobalt (Co)	7440-48-4	Vanadium (V)	7440-62-2
Copper (Cu)	7440-50-8	Zinc (Zn)	7440-66-6
Cyanide (CN^-)	57-12-5		
Lead (Pb)	7439-92-1		

Notes: This table lists the primary nonradiological constituents provided in RPP-23403 that are regulated by RCRA (i.e., also listed in Appendix 5 of Ecology Publication 97-407).

Table 3-2 lists the constituents to be analyzed for RCRA monitoring. Wells are to be sampled quarterly, semiannually, annually or biennially. Maintenance problems and sampling logistics sometimes delay scheduled sampling events. If a sampling event is delayed for more than 6 weeks, that sample will be cancelled because it will be nearly time for the next quarterly sample.

One of the 72 analytes listed in Table 3-1, chromium, has been found in groundwater and is attributed to releases from the WMA only. In addition, nitrate is present in groundwater and is attributed to releases from WMA T (see Section 2.5.1). Carbon tetrachloride and trichloroethene are also found in the groundwater but originate from waste sites associated with the PFP. Thus, chromium and the supporting constituents alkalinity, major anions (nitrate), and major cations (metals) are routinely sampled for RCRA in the network monitoring wells (Table 3-2). The supporting constituents provide information on general chemistry and allow for charge-balance computations to assess laboratory performance.

Sampling for the remaining constituents identified in Table 3-1 was performed once during the first available sample event after Revision 0 of this plan went into effect to determine if these constituents have impacted groundwater quality. Sampling was performed in the upgradient and near-field downgradient monitoring wells (Table 3-2). The constituents not detected in groundwater were removed from future sampling. If an organic constituent from Table 3-1 is detected in a groundwater sample and is not attributed to contamination from another facility (e.g., carbon tetrachloride from the PFP), a confirmation sample will be collected at the next scheduled sample event, with split samples sent to different analytical laboratories. If the detection is confirmed by positive results from both laboratories, the constituent will be added to the list of analytes for routine sampling to evaluate the extent of contamination. If the detection is not confirmed, the analyte will be removed from future sampling.

Some of the inorganic constituents included in Table 3-1 occur naturally in groundwater (e.g., barium, selenium, vanadium, and zinc). Detections of an inorganic constituent will be evaluated to determine if the constituent is present naturally by comparison to sample results from the upgradient wells and comparison to Hanford Site background values (DOE/RL-96-61, *Hanford Site Background: Part 3, Groundwater Background*). If it is determined that an inorganic constituent may be present as a contaminant from the WMA, confirmation samples will be collected (as described for the organic constituents). If contamination is confirmed, then the constituent will be added to the routine sample list to evaluate the extent of contamination. If the contamination is not confirmed, the constituent will be removed from future sampling.

3.2 Monitoring Well Network

Some of the wells in the WMA T monitoring network (Figure 3-1) are also sampled for the 200-ZP-1 OU. Sampling for WMA T and the 200-ZP-1 OU is coordinated to eliminate duplicate analyses and well trips.

Table 3-2 indicates the purpose of each well and whether the wells meet WAC requirements. Table 3-3 summarizes well construction information, including the current (March 2011) depth to water in each well. As-built diagrams for the wells showing construction details are provided in PNNL-15301 and *Borehole Data Package for Two RCRA Wells 299-W11-25B and 299-W11-46 at Single-Shell Tank Waste Management Area T, Hanford Site, Washington* (PNNL-15776).

Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA T

			RCRA Dangerous Constituent	Supporting Parameters			Field-Measured Parameters					
Well Name	**Purpose**	**WAC Compliant**	**Hexavalent Chromium**	**Nitrate (Anions)[a]**	**Metals, Unfiltered[b]**	**Alkalinity**	**pH[c]**	**Specific Conductance[c]**	**Turbidity[c]**	**Temperature[c]**	**Dissolved Oxygen[c]**	**Table 3-1 Analytes**
299-W10-1	Upgradient	N	A	A	A	A	A	A	A	A	A	Once
299-W10-4	Assessment[a]	N	A	A	A	A	A	A	A	A	A	Once
299-W10-8	Downgradient	N	A	A	A	A	A	A	A	A	A	Once
299-W10-23	Assessment[d]	Y	B	B	B	B	B	B	B	B	B	Once
299-W10-24	Downgradient	Y	A	A	A	A	A	A	A	A	A	Once
299-W10-28	Upgradient	Y	A	A	A	A	A	A	A	A	A	Once
299-W11-39	Downgradient	Y	A	A	A	A	A	A	A	A	A	Once
299-W11-40	Downgradient	Y	Q	SA	SA	A	Q	Q	Q	Q	Q	Once
299-W11-41	Downgradient	Y	Q	SA	SA	A	Q	Q	Q	Q	Q	Once
299-W11-42	Downgradient	Y	Q	SA	SA	A	Q	Q	Q	Q	Q	Once
299-W11-45	Far-field[e]	Y	SA	SA	SA	A	SA	SA	SA	SA	SA	Once
299-W11-47	Downgradient	Y	Q	SA	SA	A	Q	Q	Q	Q	Q	Once

Table 3-2. Monitoring Network, Constituent List, and Sampling Frequency for WMA T

Well Name	Purpose	WAC Compliant	RCRA Dangerous Constituent	Supporting Parameters			Field-Measured Parameters					Table 3-1 Analytes
			Hexavalent Chromium	Nitrate (Anions)[a]	Metals, Unfiltered[b]	Alkalinity	pH[c]	Specific Conductance[c]	Turbidity[c]	Temperature[c]	Dissolved Oxygen[c]	

WAC non-compliant wells were constructed prior to 1980 with carbon steel casing and perforations rather than screens.

Notes: Abbreviations in this table include the following:

A = to be sampled annually (performed in November)

B = to be sampled biennially

Q = to be sampled quarterly

SA = to be sampled semiannually

a. Anions; analytes include, but are not limited to, nitrate, chloride, sulfate, and fluoride.

b. Metals; analytes include, but are not limited to, chromium, and cations sodium, magnesium, potassium, and calcium.

c. Field measurement.

d. Assessment wells are not necessarily directly up or downgradient. Assessment wells are used to help distinguish other contaminant plumes impinging on WMA T.

e. Far-field wells are wells located far downgradient to determine lateral extent of contamination.

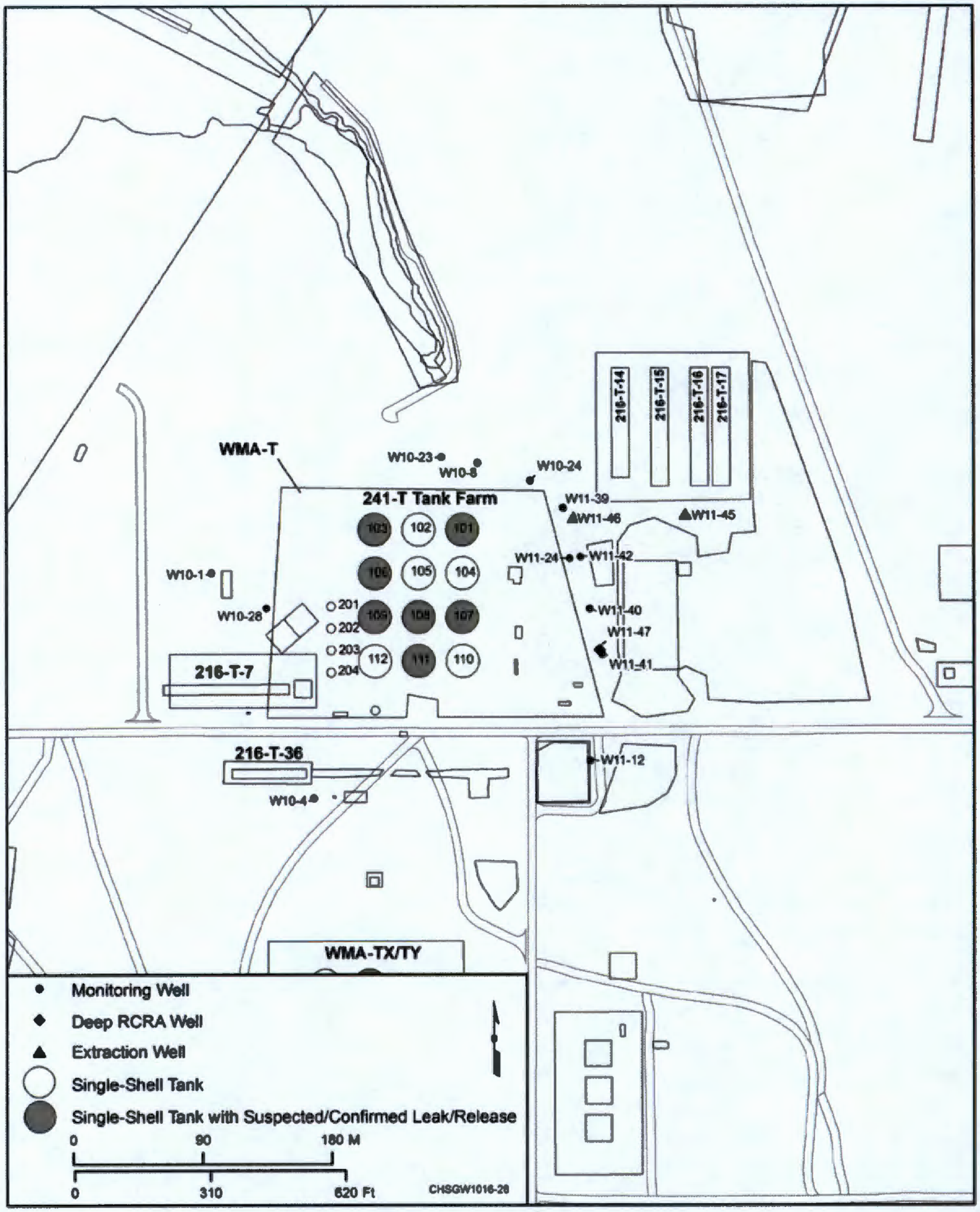

Figure 3-1. General Layout of WMA T, Including Locations of Nearby Past-Practice Facilities and Monitoring Wells

Table 3-3. WMA T Well Depths and Water Table Elevation

Well Name	Completion Date	Surface Elevation NAVD88, amsl (m)	Water Table Elevation (m), 2011	Screened Interval Bottom Elevation (m)	Water Column (m), 2011
299-W10-1	1947	206.70	133.87	124.40	19.47
299-W10-4	1952	205.20	133.74	130.52	3.22
299-W10-8	1973	207.50	133.40	131.00	2.40
299-W10-23	1998	206.56	133.60	127.04	6.56
299-W10-24	1998	208.87	133.25	127.17	6.08
299-W10-28	2001	205.92	133.60	126.61	6.98
299-W11-39	2000	209.89	132.74	126.47	6.27
299-W11-40	2000	209.70	133.29	126.45	6.84
299-W11-41	2000	209.67	133.30	126.86	6.44
299-W11-42	2000	210.18	133.50	127.34	6.16
299-W11-45	2006	212.88	133.25	122.70	10.55
299-W11-47	2006	209.66	134.30	116.76	17.54

Notes: Bold/italic print indicates upgradient wells.

amsl = above mean sea level

NAVD88 = North American Vertical Datum of 1988

Wells installed since the 1980s have been constructed to meet the requirements of WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." These wells have stainless-steel casing and screen, sand pack in the screened interval, and full annular seal above. Other wells in the network are much older and were installed before the requirements of WAC 173-160 were implemented. These wells have carbon-steel casing and perforated intervals rather than screens. In some cases, wells were later retrofit with annular seals at the surface. The use of the older wells allows continuity with historical data.

3.3 Changes to Monitoring Plan

Several changes have been made to the WMA T monitoring schedule since Revision 0 of this monitoring plan was issued. Two wells have been removed from the monitoring network, which include well 299-W11-46 because it is no longer an online extraction well and is unavailable for sampling, and well 299-W11-12 because it went dry. Figure 3-2 provides chromium data from 2011.

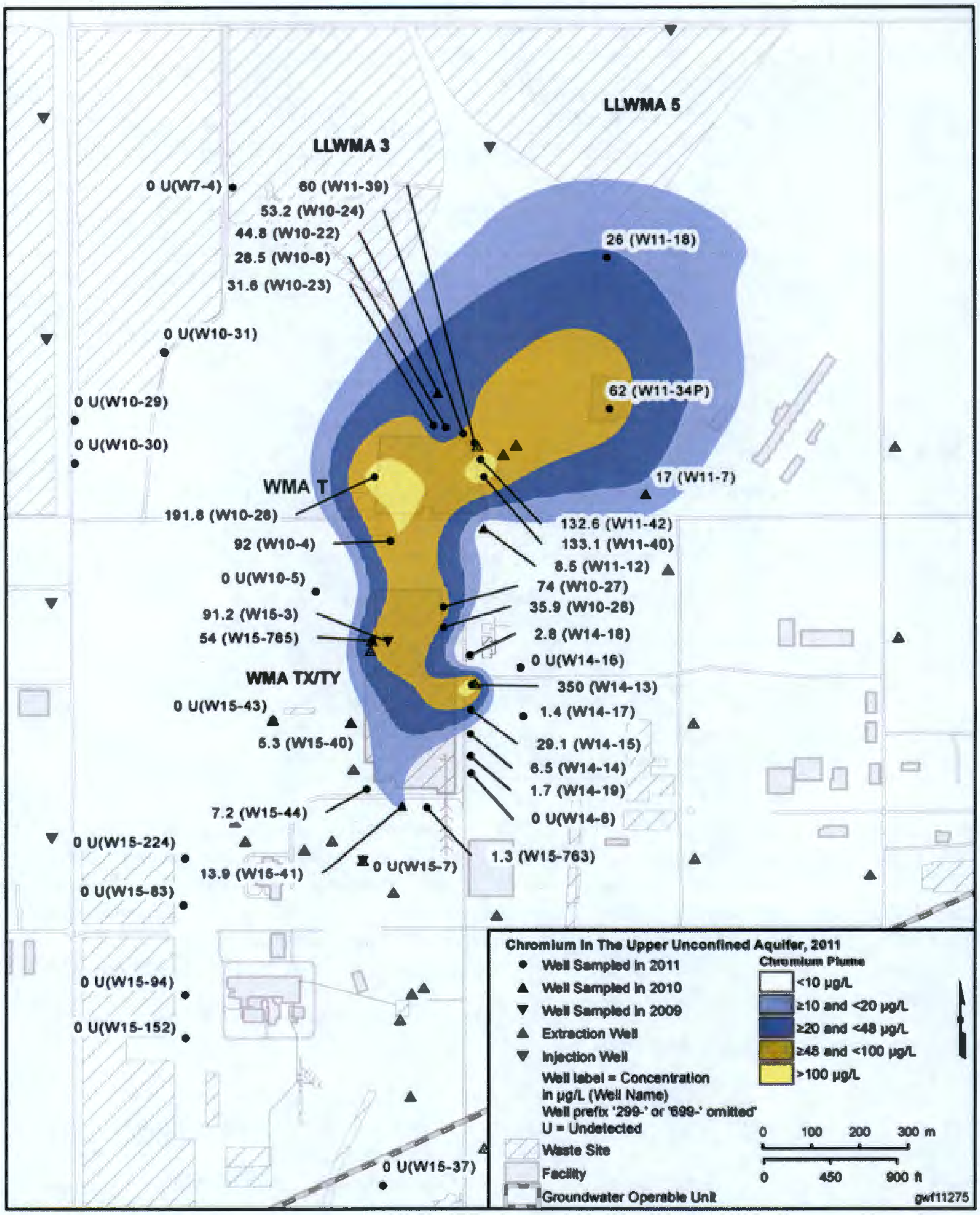

Figure 3-2. WMA T Chromium Contaminant Plume Map, 2011

The sampling frequency for many constituents has also changed. All upgradient (west) wells and all wells north of WMA T have been changed to an annual sampling frequency. Downgradient wells either remain on a quarterly frequency or have been changed to semiannual or annual, depending on the constituents monitored. Hexavalent chromium analyses have been added quarterly at downgradient wells, with annual analysis occurring at upgradient wells. This allows for elimination of filtered metals analyses, so only unfiltered metals will be sampled in the future. Table 3-4 presents the sampling frequencies for all wells in the monitoring network and further describes the rationale for changes in sampling frequency to applicable wells.

Table 3-4. WMA T Monitoring Well Network Sample Frequencies

Well	Sample Frequency	Rationale
299-W11-40, 299-W11-41, 299-W11-42, and 299-W11-47	Quarterly	Near-field downgradient monitoring wells located within higher concentration areas of existing contaminant plumes and have exhibited substantial constituent concentration variability. A quarterly frequency is needed to track concentration variations.
299-W10-24 and 299-W11-39	Annually	Near-field downgradient monitoring wells located outside of medium concentration areas of contaminant plumes. These wells are monitored to identify new contaminant plumes or changes in plume direction, depth, etc. Annual sampling frequency is used to meet these objectives. This frequency is consistent with the requirements for sites in interim status detection monitoring, which shares the common objective of identifying new contaminant plumes.
299-W10-23	Biennially	Near-field, cross-gradient assessment monitoring well exhibiting very low constituent concentrations. This well is located too far north of existing source areas to be useful for identifying new contaminant plumes; thus, there is no need to sample this well more frequently than biennially.
299-W10-4	Annually	Near-field upgradient assessment monitoring well exhibiting high to medium constituent concentrations. Contaminant concentrations have been decreasing in this well. This well is useful for identifying new contaminant plumes, which is a common objective for sites in interim status detection monitoring.
299-W10-8	Annually	Near-field or intermediate downgradient monitoring well that exhibits constituent concentrations of low variability and/or low concentrations. Annual sampling is adequate to define the concentration trends in this well.
299-W11-45	Semiannually	Far-field downgradient monitoring well located within a high-concentration area of a contaminant plume. This well has declining contaminant concentrations.
299-W10-1 and 299-W10-28	Annually	Upgradient wells monitored to establish background water quality conditions. An annual sampling frequency is sufficient to meet this objective.

Notes: Bold/italic print indicates upgradient wells.

3.4 Sampling and Analysis Protocol

Sampling and analysis protocols at WMA T follow the conventions of the project and are described in the QAPjP (Appendix A).

4 Data Evaluation and Reporting

This chapter discusses data evaluation and reporting for WMA T.

4.1 Data Review

Data review, validation, and verification are discussed in the QAPjP in Appendix A.

4.2 Interpretation

After data are validated and verified, acceptable data are used to interpret groundwater conditions at WMA T. Interpretive techniques include the following:

- **Hydrographs:** Graph water levels versus time to determine decreases, increases, seasonal, or manmade fluctuations in groundwater levels.
- **Water table maps:** Use water table elevations from multiple wells to construct contour maps and to estimate flow directions. Groundwater flow is assumed to be perpendicular to lines of equal potential.
- **Trend plots:** Graph concentrations of constituents versus time to determine increases, decreases, and fluctuations. May be used in tandem with hydrographs and/or water table maps to determine if concentrations relate to changes in water level or groundwater flow directions.
- **Plume maps:** Map distributions of chemical constituent concentrations in the aquifer to determine the extent of contamination. Changes in plume distribution over time assist in determining plume movement and direction of groundwater flow.
- **Contaminant ratios:** Can sometimes be used to distinguish among different sources of contamination.

4.3 Annual Determination of Monitoring Network

The RCRA groundwater monitoring requirements include an annual evaluation of the monitoring well network to determine if it remains adequate to monitor the WMA. The network must include upgradient and downgradient wells in the uppermost aquifer. The groundwater flow direction beneath WMA T is toward the east. The groundwater monitoring network includes upgradient (west) wells, downgradient (east) wells, and wells to the north and south of the WMA.

Water-level measurements will continue to be collected before each sampling event, and more comprehensive measurements will continue to be made in the northern portion of the 200 West Area in March of each year. The measurements are corrected, if needed, to account for borehole deviation from vertical, and the resulting data are plotted on a map. The data are presented in the annual Hanford Site groundwater monitoring report (e.g., DOE/RL-2011-118).

Wells in the WMA T monitoring network are not expected to go dry for several years, and the direction of groundwater flow is not expect to change until after the 200 West Area pump and treat is fully operational in 2012. Thus, the current monitoring network is expected to remain valid for 2 or 3 more years. This will be confirmed during the annual determination.

The RCRA monitoring will conduct assessment studies and create work plans to install new wells if necessary. Alternatives to new well construction include well network analysis using statistical methods to determine if new wells are needed to replace dry wells. Well-deepening technical evaluations are ongoing and recommendations are forthcoming. The 200-ZP-1 OU performance monitoring results and recommendations will be evaluated after the pump-and-treat system is operational.

Any new RCRA wells needed at WMA T will be negotiated and prioritized by Ecology, DOE, and EPA and approved under Tri-Party Agreement Milestone M-24-00.

4.4 Reporting and Notification

The results of assessment monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, “Recordkeeping and Reporting.” Reporting will be made in the annual Hanford Site groundwater monitoring report.

5 References

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Appendix A

Quality Assurance Project Plan

Contents

Figure

Tables

Terms

CRDL	contract-required detection limit
DOE	U.S. Department of Energy
DQO	data quality objective
DUP	laboratory matrix duplicate
EB	equipment blank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FTB	full trip blank
FXR	field transfer blank
GC	gas chromatography
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
IC	ion chromatography
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectrometry
LCS	laboratory control sample
MB	method blank
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
PCB	polychlorinated biphenyl
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
RPD	relative percent difference
RSD	relative standard deviation
SUR	surrogate

TOC	total organic carbon
TOX	total organic halides
TPA	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
VOC	volatile organic compound

A Quality Assurance Project Plan

The contractor's quality assurance (QA) program describes the contractor's QA structure, requirements, implementation methods, and responsibilities. The contractor's environmental QA program plan provides the requirements for collecting and assessing environmental data in accordance with the following:

- 10 CFR 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements"
- DOE O 414.1D, *Quality Assurance*
- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD)
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*

This quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection including the planning, implementation, and assessment of sampling, field measurements, and laboratory analyses. Sections 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order* (TPA) (Ecology et al., 1989a), Attachment 2, "Action Plan," require that QA/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal (TSD) units, as well as for past-practice processes. The HASQARD requirements (DOE/RL-96-68) also apply to this work.

The content of this QAPjP is patterned after the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to the Part B requirements of *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use* (ANSI/ASQ E4-2004). This QAPjP is divided into four sections (as designated in EPA/240/B-01/003) that describe the quality requirements and controls applicable to this investigation. This QAPjP is intended to supplement the contractor's environmental QA program plan.

A1 Project Management

This section addresses the basic aspects of project management and will ensure that the project has defined goals, the participants understand the goals and the approaches used, and the planned outputs are appropriately documented.

A1.1 Project/Task Organization

The project organization in regard to planning, sampling, analysis, and data assessment is described in the following subsections and is shown in Figure A-1. For each functional primary contractor role, there is a corresponding oversight role within the U.S. Department of Energy (DOE).

A1.1.1 Regulatory Project Manager

The Washington State Department of Ecology (Ecology) project manager is responsible for oversight of the work being performed under this groundwater monitoring plan. Ecology will work with the DOE Richland Operations Office (RL) to resolve concerns regarding the work as described in this QAPjP. Ecology can request this plan during a regulatory compliance inspection for review.

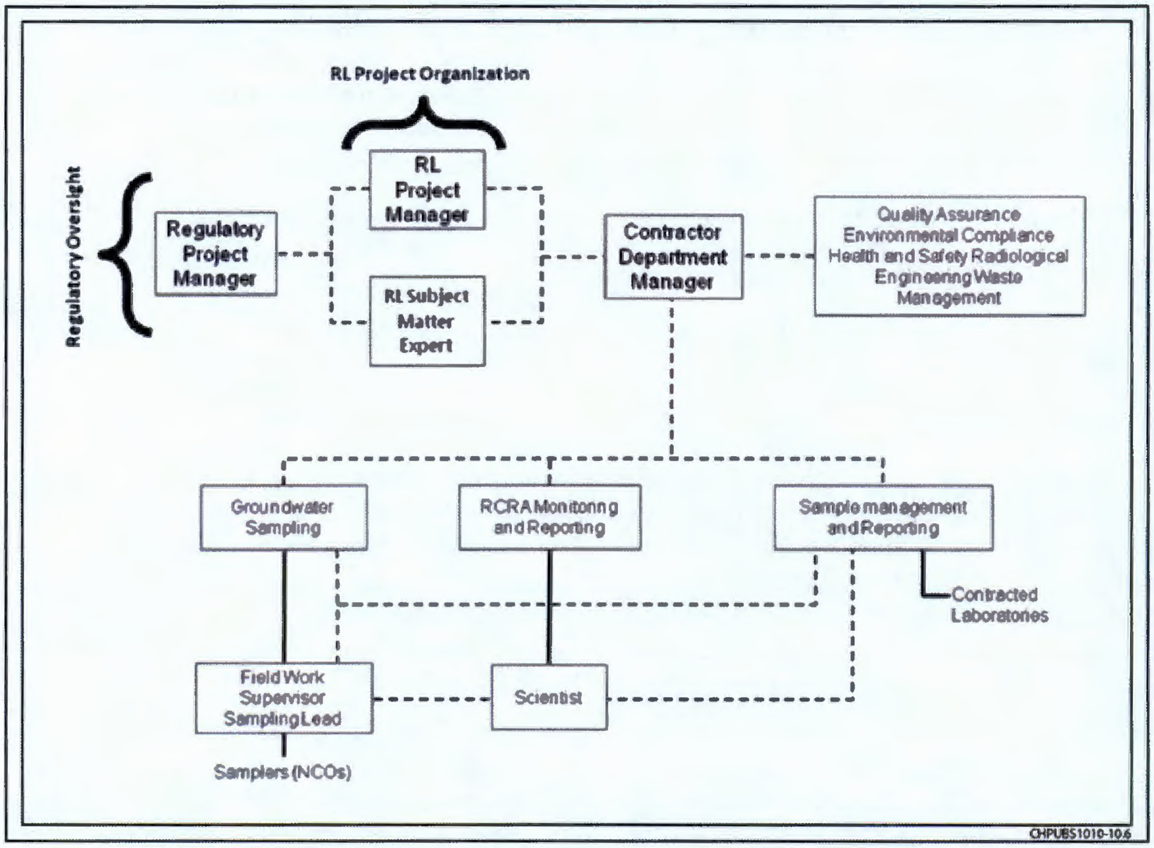

Figure A-1. Project Organization

A1.1.2 U.S. Department of Energy, Richland Operations Office Project Manager

Hanford Site cleanup is the responsibility of RL. The RL project manager is responsible for authorizing the contractor to perform activities under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*; the *Resource Conservation and Recovery Act of 1976* (RCRA); the *Atomic Energy Act of 1954*; and the TPA (Ecology et al., 1989a) for the Hanford Site.

A1.1.3 U.S. Department of Energy, Richland Operations Office Subject Matter Expert

The RL subject matter expert is responsible for day-to-day oversight of the contractor's performance of workscope, for working with the contractor and the regulatory agencies to identify and work through issues, and for providing technical input to the RL project manager.

A1.1.4 Contractor Groundwater Remediation Department Manager

The contractor groundwater remediation department manager provides oversight for all activities and coordinates with DOE, the regulatory agencies, and primary contractor management in support of sampling and reporting activities. The remediation department manager also provides support to the RCRA Monitoring and Reporting manager to ensure that work is performed safely and cost effectively.

A1.1.5 Groundwater Sampling Operations

Groundwater sampling operations is responsible for planning and coordinating field sampling resources and provides the field work supervisor for routine groundwater sampling operations. The field work supervisor directs the samplers who collect groundwater samples in accordance with the sampling and analysis plan and in accordance with corresponding standard procedures and work packages. The samplers also complete field logbooks and chain-of-custody forms, including any shipping paperwork, and ensure delivery of the samples to the analytical laboratory.

A1.1.6 RCRA Monitoring and Reporting

The RCRA Monitoring and Reporting manager is responsible for direct management of activities performed to meet RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager coordinates with and reports to DOE and primary contractor management regarding RCRA TSD monitoring requirements. The RCRA Monitoring and Reporting manager assigns scientists to provide technical expertise.

A1.1.7 Sample Management and Reporting Organization

The Sample Management and Reporting organization coordinates laboratory analytical work to ensure that laboratories conform to HASQARD requirements (or their equivalent), as approved by DOE, the U.S. Environmental Protection Agency (EPA), and Ecology. Sample Management and Reporting receives analytical data from the laboratories, performs data entry into the Hanford Environmental Information System (HEIS) database, and arranges for data validation. Sample Management and Reporting is responsible for informing the RCRA Monitoring and Reporting manager of any issues reported by the analytical laboratories.

A1.1.8 Contract Laboratories

The contract laboratories analyze samples in accordance with established procedures and provide necessary sample reports and explanations of results to support data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

A1.1.9 Quality Assurance

The QA point of contact is matrixed to the subject matter expert and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project documents, including data quality objective (DQO) summary reports, sampling and analysis plans, and the QAPjP; and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA point of contact must be independent of the unit generating the data.

A1.1.10 Environmental Compliance Officer

The environmental compliance officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work, and also develops appropriate mitigation measures with the goal of minimizing adverse environmental impacts.

A1.1.11 Health and Safety

The Health and Safety organization is responsible for coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulations or by internal primary contractor work requirements.

A1.1.12 Waste Management

Waste Management communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

A1.2 Problem Definition/Background

The problem definition, as required by WAC 173-303-400 ("Dangerous Waste Regulations," "Interim Status Facility Standards") and 40 CFR 265, Subpart F ("Interim Status Standards for Owners and

Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Ground-Water Monitoring"), is outlined in the main text discussion of this monitoring plan. The background is also provided in the monitoring plan.

A1.3 Project/Task Description

The project description is provided in Chapters 3 and 4 of this monitoring plan and includes the selection of appropriate dangerous waste or dangerous waste constituents, collection and analyses of groundwater from the monitoring network, interpretation of analytical results, evaluation of the monitoring network, and reporting.

The target analytes, along with the monitoring wells and frequency of sampling, are provided in Chapter 3.

A1.4 Quality Objectives and Criteria

The quality objectives and criteria for groundwater monitoring are defined in the tables provided in this QAPjP in order to meet the evaluation requirements stated in the monitoring plan.

A1.5 Special Training/Certification

Workers receive a level of training that is commensurate with their responsibility for collecting and transporting groundwater samples according to the dangerous waste training plan maintained for the TSD unit to meet the requirements of WAC 173-303-330, "Personnel Training." The field work supervisor, in coordination with line management, will ensure that all field personnel meet training requirements.

A1.6 Documents and Records

The project scientist is responsible for ensuring that the current version of the groundwater monitoring plan is used and for providing any updates to field personnel. Version control is maintained by the administrative document control process. Significant changes to the plan that affect DQOs will be reviewed and approved by DOE and the regulatory agency prior to implementation. Table A-1 defines the types of changes that may be made to the sampling design and documentation requirements.

Logbooks and data forms are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for the logbooks shall be identified in the front of the logbook, and only authorized individuals may make entries into the logbooks. Logbooks will be controlled in accordance with internal work requirements and processes.

The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file. Records may be stored in either electronic or hardcopy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that ensure accuracy and retrievability of stored records. Records required by the TPA (Ecology et al., 1989a) will be managed in accordance with the requirements therein.

The results of groundwater monitoring are reported annually in accordance with the requirements of 40 CFR 265.94, "Recordkeeping and Reporting." Reporting will be made in annual Hanford Site groundwater monitoring reports (e.g., DOE/RL-2011-118, *Hanford Site Groundwater Monitoring and Performance Report for 2011*.

Table A-1. Actions and Documentation for Regulatory Notification

Type of Change	Action	Documentation
Temporary addition of wells or constituents, or increased sampling frequency	RCRA Monitoring and Reporting manager approval; notify regulatory agency, if appropriate	Project's schedule tracking system
Unintentional impact to groundwater monitoring plan including one-time missed well sampling due to operational constraints, delayed sample collection, broken pump, lost bottle set, missed sampling of indicator parameters, loss of samples in transit, etc.	Electronic notification	RCRA annual report
Planned change to groundwater monitoring activities, including addition or deletion of constituents or wells, change of sampling frequency, etc.	Revise monitoring plan	Revised RCRA groundwater monitoring plan
Anticipated unavoidable changes (e.g., dry wells)	Electronic notification; revise monitoring plan	RCRA annual report and revised groundwater monitoring plan

A2 Data Generation and Acquisition

This section addresses data generation and acquisition to ensure that the project's methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

A2.1 Sampling Process Design (Experimental Design)

The sampling design is based on regulatory requirements and judgmental sampling.

A2.1.1 Regulatory Requirements

The groundwater protection regulations of WAC 173-303-400 dictate the groundwater sampling and analysis requirements applicable to interim status TSD units.

A2.1.2 Judgmental Sampling

The selection of sampling and analysis requirements is based on knowledge of the feature or condition under investigation and is also based on professional judgment. The TSD unit monitoring is based on professional judgment. Conclusions depend on the validity and accuracy of professional judgment.

A2.2 Sampling Methods

Sampling is described in the contractor's environmental QA program plan, including the following:

- Field sampling methods
- Sample preservation, containers, and holding times
- Corrective actions for sampling activities
- Decontamination of sampling equipment

The groundwater sampling operations supervisor must ensure that situations that may impair the usability of samples and/or data are documented in field logbooks or on nonconformance report forms in accordance with internal corrective action procedures, as appropriate. The groundwater sampling operations supervisor will note any deviations that occur from the standard procedures for sample collection, contaminants of potential concern, sample transport, or monitoring. The groundwater sampling operations supervisor is also responsible for coordinating all activities related to the use of field monitoring equipment (e.g., dosimeters and industrial hygiene equipment). Field personnel will document in the logbook all noncompliant measurements taken during field sampling. Ultimately, the groundwater sampling operations supervisor is responsible for developing, implementing, and communicating corrective action procedures; for documenting all deviations from procedure; and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact data quality or impair the ability to acquire data or failure to follow procedure will be documented in accordance with internal corrective action procedures, as appropriate.

A2.3 Sample Handling and Custody

A sampling and data tracking database is used to track samples from the point of collection through the laboratory analysis process. Laboratory analytical results are entered and maintained in the HEIS database. Each sample is identified and labeled with a unique HEIS sample number. The contractor's environmental QA program plan specifies sample handling information, including the following:

- Container requirements
- Container labeling and tracking process
- Sample custody requirements
- Shipping and transportation

Sample custody during laboratory analysis is addressed in the applicable laboratory's standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by the Sample Management and Reporting organization.

A2.4 Analytical Methods

Information on analytical methods is provided in Tables A-2 and A-3. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor participates in oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (μg/L)[c]
Metals Analyzed by ICP Method – Unfiltered			
Calcium	P, HNO_3 to pH <2	SW-846[d] Method 6010B/C, SW-846 Method 6020[e], or EPA/600 Method 200.8[e]	1,000
Chromium			10
Sodium			500

Table A-2. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Continuing Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Potassium			4,000
Magnesium			750
Trace Metals – Unfiltered			
Hexavalent chromium	G/P, cool to 4°C	SW-846 Method 7196	10
Anions by IC			
Chloride	P	EPA/600 Method 300.0[f]	200
Fluoride			500
Nitrate			250
Sulfate			500
Other			
Alkalinity	G/P	Standard Method[g] 2320, EPA/600 Method 310.1 EPA/600 Method 310.2	5,000
Conductivity, field	Field measurement	Instrument/meter	1 µohm
Dissolved oxygen, field	Field measurement	Instrument/meter	0 mg/L
pH, field measurement	Field measurement	Instrument/meter	0.1
Temperature	Field measurement	Instrument/meter	--
Turbidity, field measurement	Field measurement	Instrument/meter	0.1 NTU

a. All samples will be collected in plastic (P) or glass (G) containers and will be cooled to 4°C upon collection.

b. Constituents grouped together are analyzed by the same method, unless otherwise indicated.

c. Detection limit units, unless otherwise indicated.

d. SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. Analytical method adapted from Method 300.0 (EPA-600/4-84-017, *Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography*).

g. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
Metals Analyzed by ICP Method — Unfiltered/Filtered			
Barium	P, HNO_3 to pH <2	SW-845[d] Method 6010B/C SW-846 Method 6020[e] or EPA/600 Method 200.8[f]	20
Beryllium			5
Cadmium			5
Chromium			10
Cobalt			20
Copper			10
Nickel			40
Silver			10
Vanadium			25
Zinc			10
Trace Metals – Unfiltered/Filtered			
Antimony	P, HNO_3 to pH <2	SW-846 Method 6020 or EPA/600 Method 200.8	6
Arsenic			10
Lead			5
Selenium			10
Thallium			5
Trace Metals – Unfiltered/Filtered			
Mercury	G, HNO_3 to pH <2	SW-846 Method 7470A, EPA/600 Method 200.8	0.5
Volatiles by GC/MS			
1,1-Dichloroethene	G, no headspace	SW-846 Method 8260B	10
1,1,1-Trichloroethane			5
1,1,2,2-Tetrachloroethane			5
1,1,2-Trichloroethane			5
1,2-Dichloroethane			5
2-Butanone (methyl ethyl ketone)			10

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
2-Propanone (acetone)			20
4-Methyl-2-petanone (MIBK)			10
Benzene			5
Carbon disulfide			5
Carbon tetrachloride			5
Chlorobenzene			5
Chloroform			5
Ethylbenzene			5
Isobutanol			500
Methylene chloride			5
Tetrachloroethene			5
Toluene			5
trans-1,3-Dichloropropene			5
Trichloroethene			5
Trichlorofluoromethane			10
Vinyl chloride (chloroethene)			10
Xylenes			10
Semivolatiles by GC/MS			
1,2-Dichlorobenzene (o-Dichlorobenzene)	Amber glass	SW-846 Method 8270D	10
1,2,4-Trichlorobenzene			10
2-Chlorophenol			10
2-Methylphenol (o-cresol)			10
2-Nitrophenol (o-Nitrophenol)			20
2,4-Dinitrotoluene			10
2,4,5-Trichlorophenol			10
2,4,6-Trichlorophenol			10
3-Methylphenol (m-cresol)			20

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (µg/L)[c]
4-Chloro-3-methylphenol (p-Chloro-m-cresol)			10
4-Methylphenol (p-cresol)			10
Acenaphthene			10
Butylbenzylphthalate			10
Di-n-butylphthalate			10
Di-n-octylphthalate			10
Fluoranthene			10
Hexachlorobutadiene			10
Hexachloroethane			10
n-Nitroso-di-n-propylamine			10
n-Nitrosomorpholine			10
Naphthalene			10
Nitrobenzene			10
Pyrene			10
Pyridine			20
PCBs			
Aroclor 1016	G	SW-846 Method 8082	0.5
Aroclor 1221			0.5
Aroclor 1232			0.5
Aroclor 1242			0.5
Aroclor 1248			0.5
Aroclor 1254			0.5
Aroclor 1260			0.5

Table A-3. Preservation Techniques, Analytical Methods Used, and Current Method Quantitation Limits for Listed Assessment Constituents

Constituent	Collection and Preservation[a]	Analysis Methods[b]	Method Quantitation Limit (μg/L)[c]
Other			
Cyanide	P, NaOH to pH >12	SW-846 Method 9012 Standard Method[f] 4500 EPA/600 Method 335.2	5
Sulfide	G/P, 2 mL, 2N zinc acetate and NaOH pH >9, cool 4°C	Sulfides – 9030	500

a. All samples will be collected in glass (G) or plastic (P) containers and samples will be cooled to 4°C upon collection.

b. Constituents grouped together are analyzed by the same method, unless otherwise indicated.

c. Detection limit units.

d. SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

e. SW-846 Method 6010 is the preferred method; however, Method 6020 or EPA/600 Method 200.8 may be used, as long as the method quantitation limit listed is met.

f. *Standard Methods for the Examination of Water and Wastewater* (AWWA et al., 2005).

Laboratories providing analytical services in support of this QAPjP will report errors to the Sample Management and Reporting project coordinator, who will then initiate a sample disposition record. The error-reporting process is intended to document analytical errors and the resolution of those errors with the project scientist. The corrective action program addresses the following:

- Evaluation of impacts of laboratory QC failures on data quality
- Root-cause analysis of QC failures
- Evaluation of recurring conditions that are adverse to quality
- Trend analysis of quality-affecting problems
- Implementation of a quality improvement process
- Control of nonconforming materials that may affect quality

A2.5 Quality Control

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field replicates (duplicates), trip or field blanks, and equipment blanks (EBs). Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table A-4.

A2.5.1 Field Quality Control Samples

Field QC samples will be collected to evaluate the potential for cross-contamination and field sampling performance. The QC samples and the required frequency for collection are described in this section.

Table A-4. Quality Control Samples

Sample Type	Primary Characteristics Evaluated	Frequency
Field QC		
Full trip blank (FTB)	Contamination from containers or transportation	One per 20 well trips
Field transfer blank (FXR)	Contamination from sampling site	One each day; VOCs sampled
Equipment blank (EB)	Contamination from non-dedicated equipment	As needed[a]
Replicate/duplicate sample	Reproducibility	One per 20 well trips
Laboratory QC		
Method blank (MB)	Laboratory contamination	One per batch
Laboratory duplicate	Laboratory reproducibility	See footnote b
Matrix spike (MS)	Matrix effect and laboratory accuracy	See footnote b
Matrix spike duplicate (MSD)	Laboratory reproducibility/accuracy	See footnote b
Surrogate (SUR)	Recovery/yield	See footnote b
Laboratory control sample (LCS)	Method accuracy	One per batch

a. For portable Grundfos® (registered trademark of Grundfos Pumps Corporation, Colorado Springs, Colorado) pumps, EBs are collected one per 10 well trips. Whenever a new type of non-dedicated equipment is used, an EB shall be collected every time sampling occurs until it can be shown that less frequent collection of EBs is adequate to monitor the decontamination procedure for the non-dedicated equipment.

b. As defined in the laboratory contract or quality assurance plan, and/or analysis procedures.

Full trip blanks (FTBs) are prepared by the sampling team prior to traveling to the sampling site. The FTB is filled with high-purity reagent water. The bottles are sealed and transported, unopened, to the field in the same storage containers used for samples collected that day. Collected FTBs are analyzed for the same constituents as the samples. The FTBs are used to evaluate potential contamination of the samples due to the sample bottles, preservative, handling, storage, or transportation.

Field transfer blanks (FXRs) are preserved volatile organic analysis sample bottles that are filled at the sample collection site with high-purity reagent water that has been transported to the field. After collection, FXR bottles are sealed and placed in the same storage containers with the samples from the associated sampling event. The FXR samples are analyzed for volatile organic compounds (VOCs) only. The FXRs are used to evaluate potential contamination caused by conditions in the field.

The EBs are samples in which high-purity reagent water is passed through the pump or placed in contact with the sampling surfaces of the equipment to collect blank samples identical to the sample set that will be collected. The EB bottles are placed in the same storage containers with the samples from the associated sampling event. The EB samples are analyzed for the same constituents as the samples from the associated sampling event. The EBs are used to evaluate the effectiveness of the cleaning process to ensure that samples are not cross-contaminated from previous sampling events.

For the field blanks (i.e., FTBs, FXRs, and EBs), results above two times the method detection limit (MDL) are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the MDL.

Field duplicates, also known as replicates, are two samples that are collected as close as possible to the same time and same location, and they are intended to be identical. Field duplicates are stored and transported together and are analyzed for the same constituents. The field duplicates are used to determine precision for both sampling and laboratory measurements. The results of the field duplicates must have precision within 20 percent, as measured by the relative percent difference (RPD). Only field duplicates with at least one result greater than five times the MDL or minimum detectable activity (MDA) are evaluated.

Double-blind samples contain a concentration of analyte known to the supplier but unknown to the analyzing laboratory. The laboratory is not informed that the samples are QC samples. The project submits double-blind samples to assess analytical precision and accuracy.

A2.5.2 Laboratory Quality Control Samples

The laboratory QC samples (e.g., method blanks [MBs], laboratory control samples [LCSs]/blank spikes, and MSs) are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, and will be run at the frequency specified in that reference, unless superseded by agreement.

A2.5.3 Quality Control Requirements

Table A-5 lists the acceptance criteria for QC samples, and Table A-6 lists the acceptable recovery limits for the double-blind standards. These samples are prepared by spiking Hanford Site background well water with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper concentration limit determined for Hanford Site groundwater. Investigations shall be conducted for double-blind standards that are outside of acceptance limits. The results from these standards are used to determine the acceptability of the associated parameter data.

Holding time is the elapsed time period between sample collection and analysis. The contractor's environmental QA program plan provides a table with holding times. Exceeding the required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Recommended holding times depend on the analytical method, as specified in SW-846 or *Methods of Chemical Analysis of Water and Wastes* (EPA/600/4-79/020). Data associated with exceeded holding times are flagged with an "H" in the HEIS database. Data that exceed the holding time shall be maintained but potentially may not be used in statistical analyses.

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemical Parameters			
Alkalinity Conductivity pH	MB[b]	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS[e]	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
Ammonia and Anions			
Anions by IC Cyanide Sulfide	MB	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	≤20% RPD[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
Metals			
Arsenic Cadmium Chromium Lead Mercury Selenium Thallium ICP metals ICP/MS metals	MB	<CRDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	MSD	≤20% RPD[c]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"
VOCs			
Volatiles by GC/MS	MB	<2 times MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB, FXR	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

Table A-5. Field and Laboratory Quality Control Elements and Acceptance Criteria

Method[a]	QC Element	Acceptance Criteria	Corrective Action
Semi-VOCs			
PCBs by GC Phenols by GC Semivolatiles by GC/MS	MB	<2 times MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed[d]
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB	<2 times MDL[h]	Flagged with "Q"
	Field duplicate	≤20% RPD[f]	Flagged with "Q"

a. Refer to Tables A-2 and A-3 for specific analytical methods.

b. Does not apply to pH.

c. Laboratory-determined, statistically derived control limits may also be used. Such limits are reported with the data.

d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data as suspect ("Y" flag) or rejected ("R" flag).

e. Applies to TOC and TOX only.

f. Applies only in cases where one or both results are greater than five times the detection limit.

g. Determined by the laboratory based on historical data. Control limits are reported with the data.

h. For common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the acceptance criteria is less than five times the MDL.

Data flags:

B, C = possible laboratory contamination (analyte was detected in the associated MB)

N = result may be biased (associated MS result was outside the acceptance limits)

Q = problem with associated field QC sample (blank and/or duplicate results were out of limits)

Table A-6. Blind Standard Constituents and Schedule

Constituents	Frequency	Accuracy (%)	Precision (% RSD)*
Fluoride	Quarterly	±25%	≤25%
Nitrate	Quarterly	±25%	≤25%
Chromium	Annually	±20%	≤25%

* If the results are less than five times the required detection limit, then the criterion is that the difference of the results of the replicates is less than the required detection limit.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The contract laboratories participate in national studies such as the EPA-sanctioned Water Pollution and Water Supply Performance Evaluation studies. The Groundwater Project periodically audits the analytical laboratories to identify and solve quality problems, or to prevent such problems from occurring. Audit results are used to improve performance, and the summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report.

Failure of QC will be determined and evaluated during the data validation and the data quality assessment process. Data will be qualified, as appropriate.

A2.6 Instrument/Equipment Testing, Inspection, and Maintenance

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to minimize measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., documentation of routine maintenance) will be included in the individual laboratory and the onsite organization's QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with SW-846, or with auditable HASQARD and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

A2.7 Instrument/Equipment Calibration and Frequency

Specific field equipment calibration information is provided in the environmental QA program plan. Standards used for calibration will be certified and traceable to nationally recognized performance standards. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

A2.8 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables used to support sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the contractor's acquisition system and the responsibilities and interfaces necessary to ensure that items procured/acquired for contractor meet the specific technical and quality requirements. The procurement system ensures that purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users prior to use.

Supplies and consumables that are procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

A2.9 Non-Direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. If evaluation includes data from historical sources, whenever possible such data will be validated to the same extent as the data generated as part of this effort. All data used in evaluations will be identified by source.

A2.10 Data Management

The Sample Management and Reporting organization, in coordination with the RCRA Monitoring and Reporting manager, is responsible for ensuring that analytical data are appropriately reviewed, managed, and stored in accordance with applicable programmatic requirements that govern data management procedures. Electronic data access, when appropriate, will be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b). The HEIS database will be identified as a data repository for the Hanford Facility Operating Record unit file.

All field activities will be recorded in the field logbook.

Laboratory errors are reported to the Sample Management and Reporting organization on a routine basis. For reported laboratory errors, a sample disposition record will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution of the errors with the RCRA Monitoring and Reporting manager. Sample disposition records become a permanent part of the analytical data package for future reference and for records management.

A3 Assessment and Oversight

The elements discussed in this section address the activities for assessing the effectiveness of project implementation and the associated QA and QC activities. The purpose of the assessment is to ensure that the QAPjP is implemented as prescribed.

A3.1 Assessments and Response Actions

The contractor management, Regulatory Compliance, Quality, and/or Health and Safety organizations may conduct random surveillances and assessments to verify compliance with the requirements outlined in this QAPjP.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratory's QA plan. The primary contractor conducts oversight of offsite analytical laboratories to qualify the laboratories for performing Hanford Site analytical work.

A3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. Issues reported by the laboratories are communicated to the Sample Management and Reporting organization, which initiates a sample disposition record in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the RCRA Monitoring and Reporting manager.

A4 Data Validation and Usability

The elements in this section address the QA activities that occur after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying project objectives. These elements are further discussed in the contractor's environmental QA program plan.

A4.1 Data Review, Verification, and Validation

The criteria for verification may include review for completeness (e.g., all samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

A4.2 Verification and Validation Methods

The work activities shall follow documented procedures and processes for data validation and verification, as summarized below. Validation of groundwater data consists of assessing whether the data collected and measured truly reflect aquifer conditions. Verification means assessing data accuracy, completeness, consistency, availability, and internal control practices to determine overall reliability of the data collected. Other DQOs that shall be met include proper chain-of-custody, sample handling, use of proper analytical techniques as applied for each constituent, and the quality and acceptability of the laboratory analyses conducted.

Groundwater monitoring staff perform checks on laboratory electronic data files for formatting, allowed values, data flagging (i.e., qualifiers), and completeness. Hardcopy results are verified to check for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems encountered during analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff work with the laboratory to correct the problem found during the analysis.

The data validation process provides the requirements and guidance for validating groundwater data that are routinely collected. Validation is a systematic process of reviewing verified data against a set of criteria (provided in Section A2.5) to determine whether the data are acceptable for their intended use.

Results of laboratory and field QC evaluations, double-blind sample results, laboratory performance evaluation samples, and holding-time criteria are considered when determining data usability. Staff review the data to identify whether observed changes reflect changes in groundwater quality or potential data errors, and they may request data reviews of laboratory, field, or water-level data for usability purposes. The laboratory may be asked to check calculations or re-analyze the sample, or the well may be resampled. Results of the data reviews are used to flag the data appropriately in the HEIS database (e.g., "R" for reject, "Y" for suspect, or "G" for good) and/or to add comments.

A4.3 Reconciliation with User Requirements

The data quality assessment process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet project DQOs. The RCRA Monitoring and Reporting manager is responsible for determining if data quality assessment is necessary and for ensuring that, if required, one is performed. The results of the data quality assessment will be used in interpreting the data and determining if the objectives of this activity have been met.

A5 References

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